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FORMAL VERSUS SITUATIONAL MODELS OF EXPERT DECISION-MAKING.(U)
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# FORMAL VERSUS SITUATIONAL MODELS OF EXPERT DECISION-MAKING

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After studying the skill acquisition process of pilots, automobile drivers, nurses, chess players, musicians, foreign language learners, and business managers, we have constructed a five-stage model describing the development of their skills. Briefly, performers at the first stage of development (novices) learn to context-free features and to use strict rules to determine actions. As they accumulate enough experience to become advanced beginners, performers identify, and relate by rule, features of the situation

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which are no longer context-free but are recognized as similar to previously experienced features. At both of these stages, the performer treats all feature as equally important. At the third level of skill, competence, the performer learns to organize a situation by consciously choosing a goal. The choice of a goal entails that different features have different degress of importance, thereby establishing a perspective. Decisions are chosen which further goals. After yet more experience with many concrete situation, a very important transformation occurs. On the basis of expectations and immediately preceding experience, whole situations present themselves to a proficient performer with only their salient features manifest. No longer does the performer consciously select a perspective from among alternatives. The performer chooses an action on the basis of rules operation over salient features of the manifest perspect. Finally, the expert performer has somehow stored such a wealth of experience that the appropriate action simply springs to mind. The expert can further enchance his performance by abandoning his evaluating and learning capacities in favor of total involvement in experiencing and reacting. Most models, including one by Perceptronics developed for the Air Force, treat all variables as equally important, thereby modeling performance at, at best, the advanced beginner level. Contrary to the prevailing dogma that skill acquisition moves from concrete situation recognition to the internalization of increasingly subtle and abstract rules, our research indicates that, in fact, the process moves in precisely the contrary direction. Novice behavior is inflexible and rule-like, whereas expert performance is flexibly responsive to the situation.

FINAL REPORT

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## I. Research Results

After studying the skill acquisition processes of pilots, automobile drivers, nurses, chess players, musicians, foreign language learners, and business managers, we have constructed a five-stage model describing the development of their skills. This model is described in detail in its final form in Reference [1]. References [2] and [3] contain earlier versions of this model as it was being developed. Briefly, performers at the first stage of development (*novices*) learn to identify context-free features and to use strict rules to determine actions. As they accumulate enough experience to become *advanced beginners*, performers identify, and relate by rule, features of the situation which are no longer context-free but are recognized as similar to previously experienced features. At both of these stages, the performer treats all features as equally important. At the third level of skill, *competence*, the performer learns to organize a situation by *consciously choosing* a goal. The choice of a goal entails that different features have different degrees of importance, thereby establishing a perspective. Decisions are chosen which further goals. After yet more experience with many concrete situation, a very important transformation occurs. On the basis of expectations and immediately preceding experiences, whole situations *present themselves* to a *proficient* performer with only their

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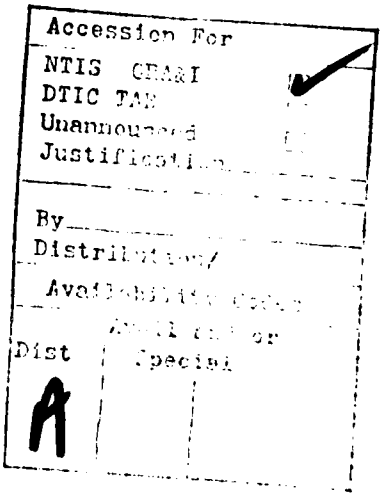
salient features manifest. No longer does the performer consciously select a perspective from among alternatives. The performer chooses an action on the basis of rules operating over salient features of the manifest perspective. Finally, the *expert* performer has somehow stored such a wealth of experience that the appropriate action simply springs to mind.

In Reference [4] we describe how the expert can further enhance his performance by abandoning his evaluating and learning capacities in favor of total involvement in experiencing and reacting.

It was noted in Reference [5] that most models, including one by Perceptronics developed for the Air Force, treat all variables as equally important, thereby modeling performance at, at best, the advanced beginner level.

Contrary to the prevailing dogma that skill acquisition moves from concrete situation recognition to the internalization of increasingly subtle and abstract rules, our research indicates that, in fact, the process moves in precisely the contrary direction. Novice behavior is inflexible and rule-like, whereas expert performance is flexibly responsive to the concrete situation.



## II. Training Implications

The obvious training implication of this five-stage model is that instructors should identify the level of proficiency of their students so that their interventions help trainees move to the next stage. Instruction in terms of context-free rules and principles, no matter how subtle, invites regression and in no way promotes progress through the developmental stages. The novice should be taught to identify situationally dependent features; the advanced beginner, to choose perspectives and saliences; the competent performer, to remain involved in the evolving situation thereby allowing saliences to present themselves to him; and the proficient performer, to trust his spontaneous responses without feeling compeled to justify them analytically. If the expert can be taught anything, it is that, in emergencies, he should become totally absorbed in the situation without self-consciously monitoring and evaluating his performance. Furthermore, expert confidence is undetermined to no advantage if he is made to feel that he ought to be able to explain by analytical principle why he does what he does.

Our research suggests that, to facilitate training at all levels of skill beyond novice, situational realism and subject involvement are essential for the mental processing and storage which converts concrete experience into available skills.

## III. Recommended Further Research

While we now have a general theory, one further step is needed before these ideas can be embodied in actual training manuals. Trained observers of the skill acquisition process must acquire expertise in each particular skill that is to be taught. Using our model as an hypothesis to direct their attention, they should note what type of experiences and instructions help bring about transition from each lower to each higher stage. Manuals should clearly indicate the level of skill assumed, and the level to be taught.

Reference [6] by Sudnow is an example of the sort of careful self-observation we propose, applied to the acquisition of jazz improvisation skills. Based upon his observations, Sudnow is currently developing a completely novel jazz-piano instructional manual.

In addition to the above implementational recommendation, an experimental program can be envisioned to verify each step of our skill acquisition model. Because the level of chess skill is objectively identifiable and chess games can be played under laboratory conditions without degrading the skill, the acquisition of chess-playing skill seems ideally suited for such an undertaking. For example, using chess players, the crucial conclusion that top level performers respond immediately to concrete situations, whereas less proficient performers must have recourse to analytical calculations to determine their actions, could be tested as follows: Players of clearly expert quality (international masters) could play a series of games among themselves at both normal tournament

speed (which would allow time for complex analytical calculation) and at blitz speed (which demands immediate intuitive responses). Middle rank players (experts) and amateur players (Class B) could do likewise. If the level of performance of international masters, as evaluated by even stronger (grandmaster) players, degraded significantly less, when time pressure prohibits calculation, than the performance of the less skilled players, one would have evidence that analytical calculation is essential to low level skilled performance but plays no essential role in expertise.

Experiments could also be devised to test whether middle level performers think in terms of perspectives and see features as salient, and whether advanced beginners are more able to identify situational features than rank novices. These experiments could take the form of showing various levels of players realistic chess positions and determining whether what a player picks out in describing situations corresponds with what one would expect given the model and the player's official rank. The AMICAE Project, a consortium of nurses studying the development and evaluation of nursing skills, has begun this sort of program. Nurses of various levels of skill are interviewed concerning real hospital experiences, and their responses concerning awareness of salient features, guidance by goals, and spontaneity of action have been found to conform with the predictions of our skill acquisition model.

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